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Drinking Water: Man-made Chemicals

This NebGuide discusses recommended practices to manage man-made chemicals in a domestic water supply.

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Many Nebraskans are concerned about the effects some of the man-made chemicals that have become part of everyday life may have on their water supply. As the name implies, these chemicals do not exist in nature but were made by man. With proper storage and use of these chemicals and with proper well construction, the risks to groundwater from the chemicals are low and the benefits are many.

In some areas of the state, however, industrial solvents, manufacturing chemicals, ammunition wastes, pesticides and grain fumigants have been detected in groundwater. In many cases the sources of the contamination could be identified, clean-ups are underway, and alternative water supplies are being used. Often the contamination occurred many years ago.

Sources of Man-made Chemicals in Drinking Water

Scattered throughout Nebraska are areas that have both sandy soils and shallow water tables. The high permeability of these soils, combined with the relatively short distance to the water table, make these areas particularly sensitive to contamination. Excessive rainfall or over-irrigation can cause downward movement of water through the soil profile. Those man-made chemicals which do not bind strongly to soil particles can be carried with the downward moving water and eventually can be leached to the groundwater.

Leaching and groundwater contamination also takes place in areas without sandy soils or a high water table, only at a slower rate.

Activities near a well, particularly mixing or storing chemicals, potentially can contaminate the water supply. In some areas, depending on the relative location of the well and sites where various man-made chemicals are used, contamination could occur from normal application and use. Used motor oil dumped on the ground, spilled fuel near storage tanks, pesticides spilled during mixing and loading, and improperly dumped household products are all examples of man-made chemicals that could leach to groundwater. In addition, leaking underground fuel tanks can contaminate groundwater without visible evidence on the surface.

Man-made chemicals also can enter groundwater through more direct routes. Improperly constructed wells or older wells with leaks around or through the casing can allow contaminants to seep into groundwater. Abandoned wells that are not properly sealed also provide direct pathways to the aquifer. Pesticide applications near such wells or any chemical spills on the surface could potentially contaminate groundwater if surface runoff moves toward the well.

Prevention of spills and immediate cleanup of any spills are among the best ways to prevent contamination of groundwater with man-made chemicals. Proper site selection and construction of domestic water wells can reduce potential contamination of drinking water. Wells that are no longer needed should be properly decommissioned to eliminate direct conduits to the aquifer.

Indications of Man-made Chemicals

Most man-made chemicals are undetectable in water without testing since they are colorless, odorless, and tasteless in the low concentrations that may occur. Public water supplies are required to be tested regularly and treatment is used, if needed, to meet established drinking water standards. If your water supply is a private well, you should consider testing if a chemical has been spilled near the well or if there is another reason to suspect contamination. Unfortunately, there is no single test for man-made chemicals and individual tests can be expensive, from about $50 to more than $200 each depending on the chemical being tested for.

If fuels, pesticides, or other chemicals are spilled near the water supply, the spill should be cleaned up immediately and the well should be tested. Unfortunately, any chemical remaining after cleanup may take a long time to move through the soil profile. Follow-up testing may be needed to monitor the effects of the spill.

By the time the chemical is detected in a well, a lot of soil and groundwater already may be contaminated. This affected soil may continue to pollute percolating water for many years. This is a particular concern in some areas where the spills or contamination occurred many years ago. Examples include: compounds like TNT and RDX from ammunition plants which have been closed for more than 30 years, products like carbon tetrachloride and chlordane once used for grain storage fumigation, and PCBs which are no longer sold but still may be in use.

Volatile organic compounds are found in a variety of solvents, pesticides, household cleaning supplies, industrial wastes, and fuels in underground storage tanks. Many of these products and other man-made chemicals do not reach the groundwater themselves, but their chemical constituents and/or breakdown products may contaminate the water supply.

For instance, petroleum fuels contain a number of potentially toxic compounds including common

solvents such as benzene, toluene and xylene, and additives such as ethylene dibromide and organic lead compounds. Therefore, knowing what to test for after a spill can be complicated and may require some knowledge of the chemical mixture and the degradation processes involved. The Nebraska Department of Health's Division of Drinking Water and Environmental Sanitation or the Environmental Protection Agency may be able to advise you on the appropriate testing.

Potential Health Effects

Health hazards from man-made chemicals vary depending on the chemical, the exposure, and the individual. Some examples of potential health hazards associated with man-made chemicals are given in *Table I*. The Environmental Protection Agency (EPA) has publications related to almost every contaminant and can provide information on the hazards, treatment, and ways to deal with specific chemicals. For current information on a specific chemical, call the EPA's Drinking Water Hotline (1-800-426-4791).

In 1986, public concerns about drinking water quality prompted Congress to amend the 1974 Safe Drinking Water Act. The amendments initially required that 83 contaminants be regulated and 25 more be added to the list every three years. The EPA has set maximum contaminant levels (MCLs) for public water systems for the listed contaminants and revises that list every three years. The MCLs for some common man-made chemicals in Nebraska which could leach to the groundwater are given in *Table I*.

Table I. Maximum contaminant levels (MCL) and potential health effects for selected man-made chemicals in drinking water.

Contaminant	*MCL, ppm*	*Potential Health Effects*
Pesticides		
Alachlor	0.002	Cancer risk
Atrazine	0.003	Liver/kidney/lung/heart effects and cancer risk
Chlordane	0.002	Known cancer agent
2,4-D	0.07	Liver/kidney effects
Volatile Organic Compounds		
Benzene	0.005	Cancer risk
Carbon Tetrachloride	0.005	Cancer risk
Toluene	1	Liver/kidney/nervous/circulatory effects
Xylenes	10	Liver/kidney/nervous system effects

Health effects that may result from drinking contaminated water are classified as either acute or chronic. Acute effects occur immediately or within days after exposure. Chronic effects occur as a result of long-term ingestion of small amounts of a chemical.

Generally, the concentrations of man-made chemicals in groundwater supplies are low and chronic effects are the greatest concern for these chemicals. Most MCLs are based on a lifetime consumption of contaminated water and are established to protect the public from chronic effects. For some of the contaminants, the human body can tolerate chemical doses that exceed the MCL for short periods of time. A physician should be consulted regarding concerns about the health effects of specific contaminants in the drinking water.

Some contaminants may pose hazards other than drinking water safety. For instance, volatile organic compounds tend to evaporate rapidly at normal room temperatures and pressures. When dissolved in water, they move from the water into the surrounding air. This is especially acute whenever the water is agitated or aerated, as it is in a washing machine, dishwasher or shower. Some of these compounds may create problems when inhaled or even may be flammable at high concentrations.

Testing

Tests for man-made chemicals can be performed by several reputable laboratories. Because of the expense, however, concerned homeowners will probably want to limit their testing to just the specific chemicals that are most likely to be present. Potential contaminants could include: any chemical spilled near the well, chemicals commonly used or stored near the well, or chemicals that previously have been detected in groundwater in the area.

If there is no reason to suspect the presence of a particular man-made chemical, tests for coliform bacteria and nitrate can give an indicator of the vulnerability of the well to contamination. The well is probably structurally sound if the coliform and nitrate levels are safe. If the well is sound and no chemical spills have occurred near the well, the likelihood of finding health-threatening levels of man-made chemicals in the water is low.

Tests for chemicals and bacteria can be performed, for a fee, by the Nebraska State Department of Health Laboratory, some city/county health department laboratories, and some commercial laboratories. See NebGuide G89-907, *Water Testing Laboratories*, for a list of laboratories in Nebraska providing water testing. Your nearest University of Nebraska Cooperative Extension office or Natural Resources District office can assist you in obtaining a kit or directing you to a laboratory.

Select a laboratory and obtain a drinking water test kit from them for the specific test desired. The kit will contain a sterilized sample bottle, an information form, sampling instructions, and a return packing box. The sample bottle likely will be test-specific and should be used only for samples intended for the specific analysis.

Be sure to carefully read and follow the sampling and handling instructions provided by the laboratory. Testing for man-made chemicals may require special sampling and handling procedures. For instance, the samples may need to be cooled and/or transported directly to the lab immediately, rather than being mailed. Avoid sampling on Fridays, weekends or holidays which may delay the lab analysis or the mail.

Although field test kits are available for detecting some chemical contaminants in water, they are not as accurate as laboratory procedures. The accuracy of the field test kits can be altered by the presence of other chemicals in the water. Laboratory testing should be used to obtain the most accurate and reliable results.

Interpreting Test Results

The laboratory will report the chemical concentration as milligrams per liter (mg/L) or as parts per million (ppm), which are equivalent for the chemical concentrations occurring in water (1 mg/L = 1 ppm). Laboratories may express organic chemical concentrations in parts per billion (ppb) or micrograms per liter (µg/L), which also are equivalent.

EPA requires regular testing of public water systems for several potential contaminants and these test results are available from the supplier. These systems must comply with the MCL standards in order to

be an approved water supply. If a test ever indicates that the chemical concentration of a contaminant in the delivered water exceeds the allowed MCL standard, the public must be notified and action must be taken to provide safe water.

Individual private wells are not required to meet the EPA water quality standards, but the standards can be used to assess the potential health risk of any drinking water supply. In addition, some lending agencies may require water testing before making individual housing loans.

Options

If man-made chemicals are present in your water supply, you have two choices: obtain an alternate water supply or use some type of treatment to remove the contaminant or reduce its concentration.

The need for action should be established before making an investment in equipment or an alternate water supply. Base the decision on the analysis by a reputable laboratory, and after consulting with a physician concerning potential health risks.

Alternate water supply

It is possible that a satisfactory alternate water supply may be obtained by drilling a new well in a different location, or a deeper well in a different aquifer. A new well should be constructed so surface contamination cannot enter the well. It should be located away from any potential sources of contamination, such as septic systems or underground fuel storage tanks.

The Division of Drinking Water and Environmental Sanitation in the Nebraska Department of Health may be able to assist you in determining the cause of water contamination and make recommendations to correct the problem. In addition, the Conservation and Survey Division of the University of Nebraska-Lincoln can provide general information on the possible location of a water supply with satisfactory quality. Both are based in Lincoln but have offices at several locations across the state.

Another alternate source of water is bottled water that can be purchased in stores or direct from bottling companies. This alternative might be considered, especially when the primary concern is water for drinking or infant food.

The Nebraska Department of Agriculture licenses and inspects bottling companies, but does not routinely sample bottled water. Consumers should assure themselves of the purity, general quality and bacterial quality of any water purchased. In all cases, the purchased water must be handled and stored in a manner to prevent contamination.

Treatment

Man-made chemicals can be removed from household drinking water by three primary methods: activated carbon filters, reverse osmosis, and distillation. Home treatment equipment using these processes is available from several manufacturers. **No single type of treatment system will remove all man-made chemicals**. That's why it is desirable to identify specifically (if possible) which contaminants are present in the water. Then ask the water treatment equipment dealer for equipment performance data on removal of the contaminants of concern.

Activated carbon or charcoal filters work like a "chemical sponge," absorbing chemicals with a natural affinity for carbon. This makes these filters the method of choice for removing many organic

compounds from water. **The contaminants are retained in the filter, so regular filter replacement is important**.

A build-up of contaminants could result in a high concentration being flushed through the filter and into the drinking water. Activated carbon filters also can be used to solve many taste and odor problems, but **they do not remove nitrate or bacteria**.

In the reverse osmosis (RO) process, pressure is applied to water to force it through a semipermeable membrane. Water molecules, which are relatively small, pass through the membrane. Some man-made chemicals (those consisting of relatively large molecules) cannot pass through and are removed from the water.

Actual removal rates may vary somewhat, depending on the initial quality of the water, the system pressure, water temperature, and the molecular size of the contaminant. For each gallon of water treated with a typical RO unit, approximately 4 to 6 gallons must be used to flush contaminants off the membrane, so water use will increase.

The distillation process involves heating water to boiling and collecting and condensing the steam by means of a metal coil. Chemicals with boiling points much higher than water are most effectively removed by this process. Merely boiling water will decrease the concentration of only chemicals with boiling points much lower than water. However, these contaminants are released into the air as the water boils. **Chemicals with boiling points near that of water**, like some volatile organic compounds, boil with the water and condense with the steam and therefore **cannot be easily removed by distillation**. Some distillation equipment uses special venting and pre- and post-filters to deal with these contaminants.

All of the methods described here for the removal of contaminants are relatively expensive. Consider both initial cost and operating costs. Operating costs include the cost for energy that may be needed to operate the system, replacement filters, increased water use to flush the system, and repair and maintenance costs.

Even the highest quality equipment will not perform satisfactorily unless it is maintained in accordance with the manufacturer's recommendations. Maintenance of the equipment may include periodic cleaning and replacement of some components. Also consider any special installation requirements that may add to the cost of the equipment.

Reputable water conditioning equipment dealers can assist you in evaluating available equipment. Equipment should be purchased only through reputable dealers and manufacturers. This helps assure the equipment will perform the necessary task, and maintenance and repair parts will be available when needed. Check to see if the equipment has been tested or evaluated by an independent agency.

The Water Quality Association (WQA) and the National Sanitation Foundation (NSF) both operate voluntary programs to test water treatment equipment for manufacturers. Equipment listed by WQA and NSF has been evaluated, meets the requirements of the test standards requirements, and normally has a label identifying the WQA or NSF testing. This independent testing provides some assurance that the manufacturers' claims have been verified.

Summary

In some areas, man-made chemicals in the water supply can be a concern. A water test is the only way to

detect a chemical and determine if the contaminant concentration is under the acceptable MCL set by EPA. Proper storage, use and disposal of chemicals and proper well location and construction are the keys to avoiding contamination of the groundwater. **Remember -- it is easier to prevent water contamination caused by man-made chemicals before it happens than it is to clean it up afterwards**.

If the drinking water supply is contaminated, the choices are to use an alternate water supply or treat the water. An alternate supply may be bottled water for drinking or a new well in a different location or aquifer. Water treatment options include activated carbon filters, reverse osmosis or distillation. Remember to choose a water treatment system that is specific for the contaminants in the water.

Related Publications

- EC94-135, *Understanding Pesticides and Water Quality in Nebraska*
- EC98-765, *Improving Drinking Well Condition*
- EC98-766, *Drinking Water Well Condition*
- EC90-2502, *Perspectives on Nitrates*
- G89-946, *Water Treatment Equipment: Water Softeners*
- G90-976, *Water Treatment Equipment: A Buyer's Guide*
- G90-989, *Drinking Water: Bacteria*
- G92-1079, *Home Water Treatment Equipment: An Overview*
- G95-1255, *Shock Chlorination of Domestic Water Supplies*
- G96-1274, *Drinking Water: Hard Water*
- G96-1275, *Drinking Water: Sulfates and Hydrogen Sulfide*
- G96-1279, *Drinking Water: Nitrate-Nitrogen*
- G96-1280, *Drinking Water: Iron and Manganese*
- G97-1333, *Drinking Water: Lead*
- G98-1360, *Drinking Water: Copper*
- G98-1369, *Drinking Water: Nitrate and Methemoglobinemia*

For information on current drinking water guidelines and man-made chemicals, contact the U.S. Environmental Protection Agency Safe Drinking Water Hotline in Washington D.C. at 1-800-426-4791 or the Nebraska State Department of Health Laboratory, 3701 South 14th Street, P.O. Box 275S, Lincoln, Nebraska, 68502.

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